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**(56) Documents Cited**

**GB 2226071 A**

**GB 1131310 A**

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EP 0075055 A1

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US 4702507 A

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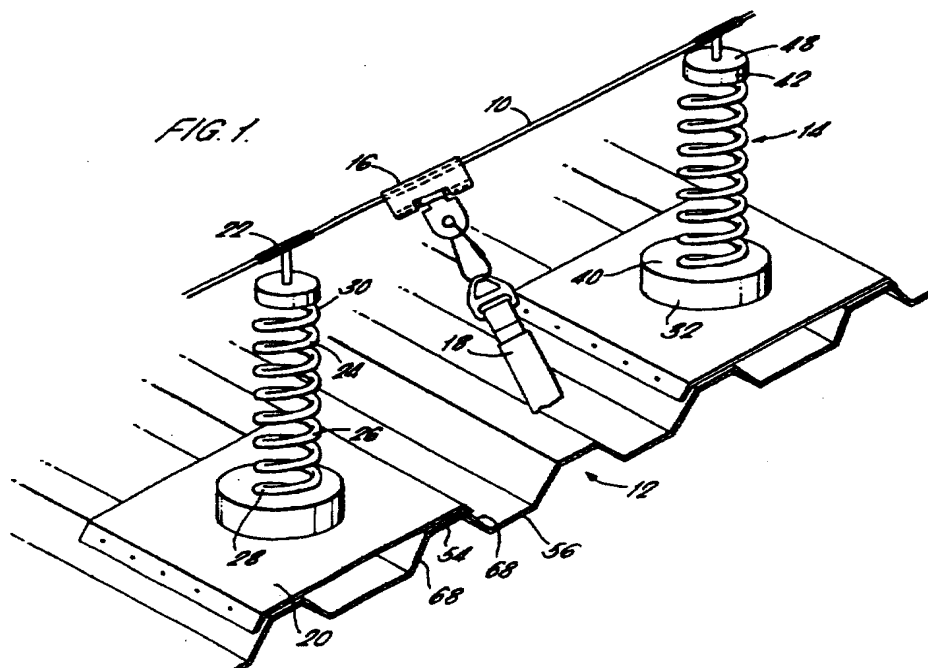
INT CL<sup>7</sup> A62B 1/16 35/04 . E04G 21/32 . E06C 7/18

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(54) Abstract Title

### Shock absorbing support and fall-arrest system

(57) A personnel fall-arrest or fall-restraint system comprising a cable 10 and shock absorbing supports 14 for holding the cable in spaced relation to a structure 12 and which are located at intervals along the cable. A safety line 18 connectable to a worker's safety line harness is provided together with a coupling component 16 for connecting the safety line to the cable. The coupling component is coupled to the cable so as to be freely displaceable therealong. The shock absorbing supports comprise a base 20 for attachment to the structure and an anchor element 22 for receipt of the cable. The anchor element is joined to the base by helical spring means 24.



At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

GB 2351789 A

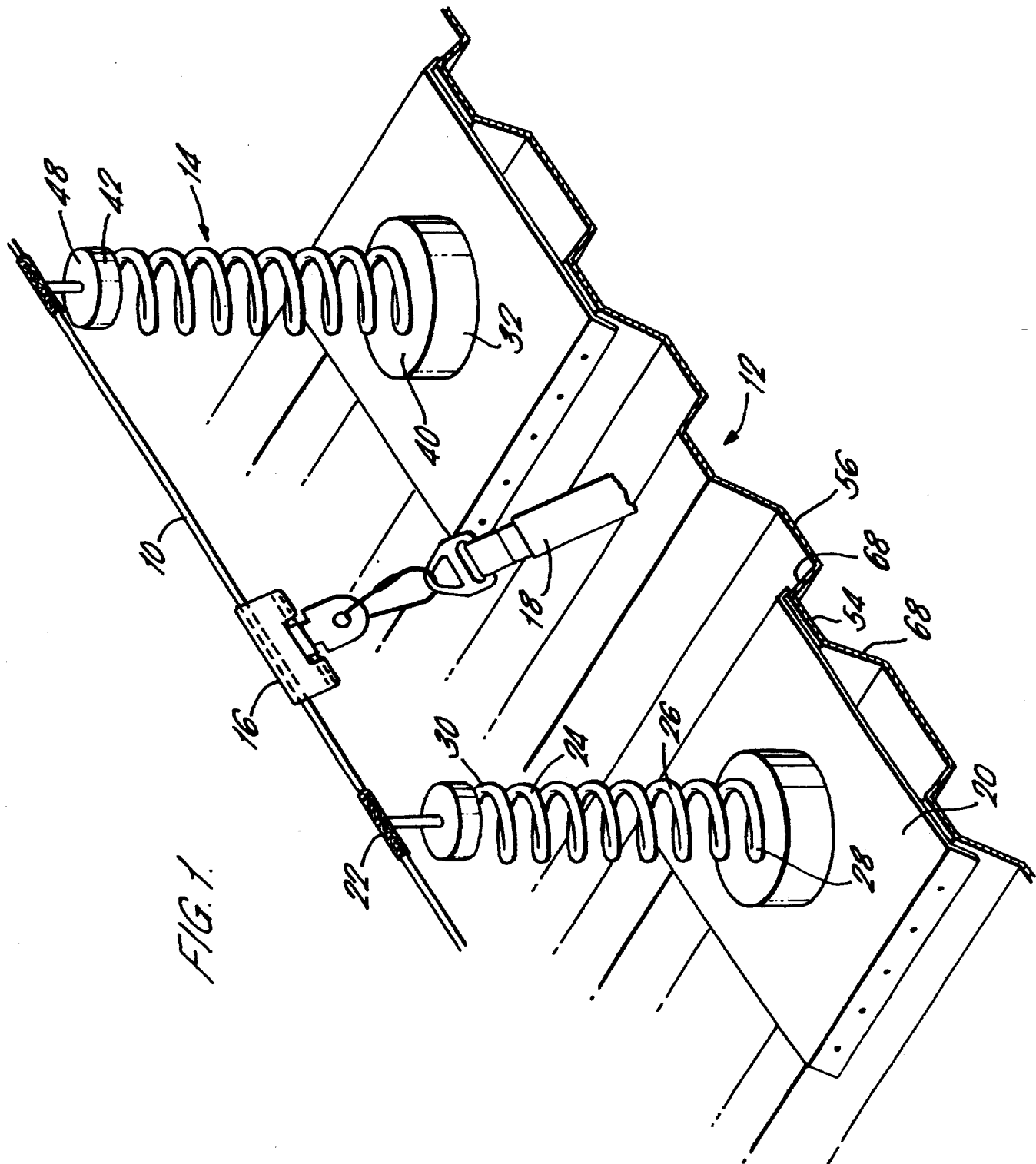


FIG. 1.

FIG. 2.

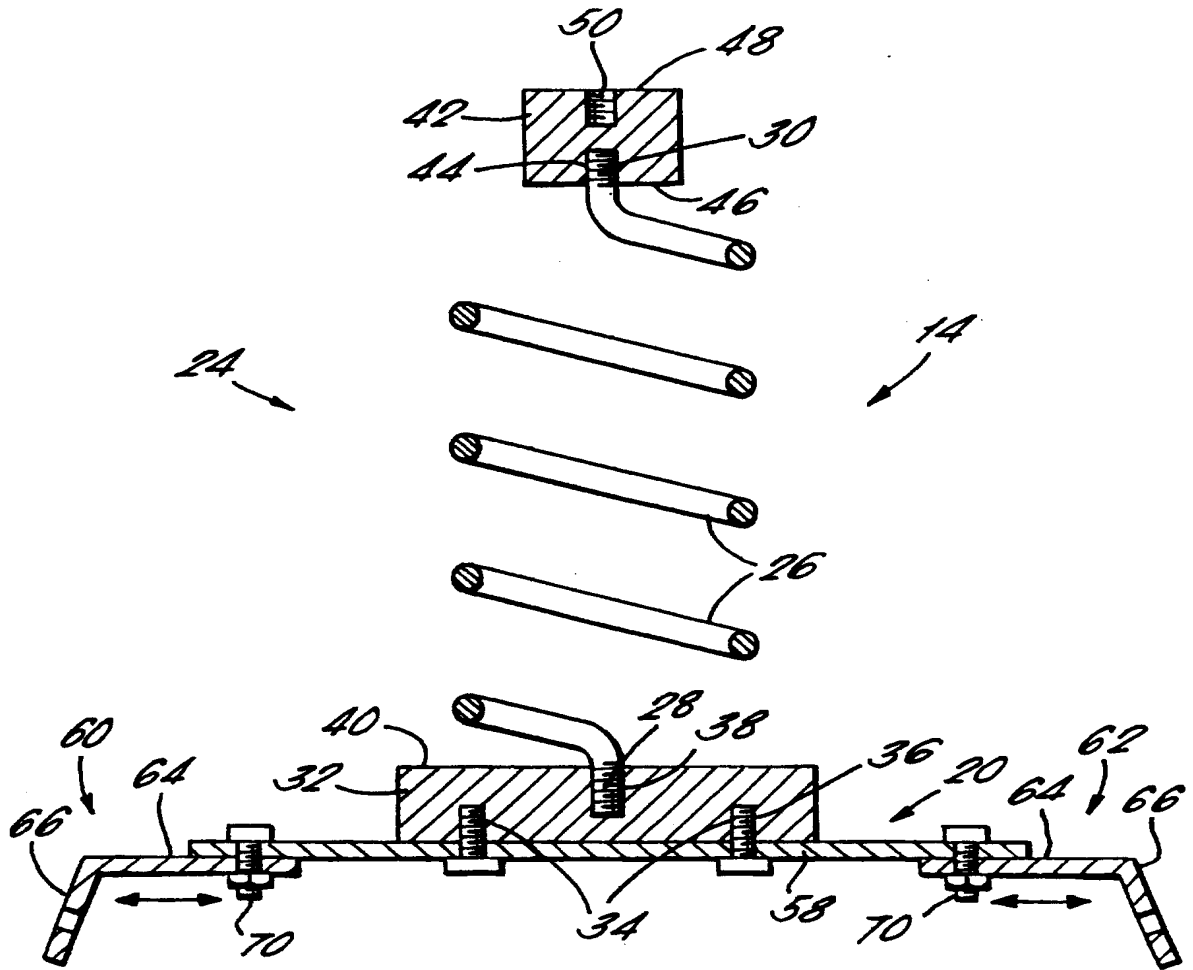


FIG. 3.

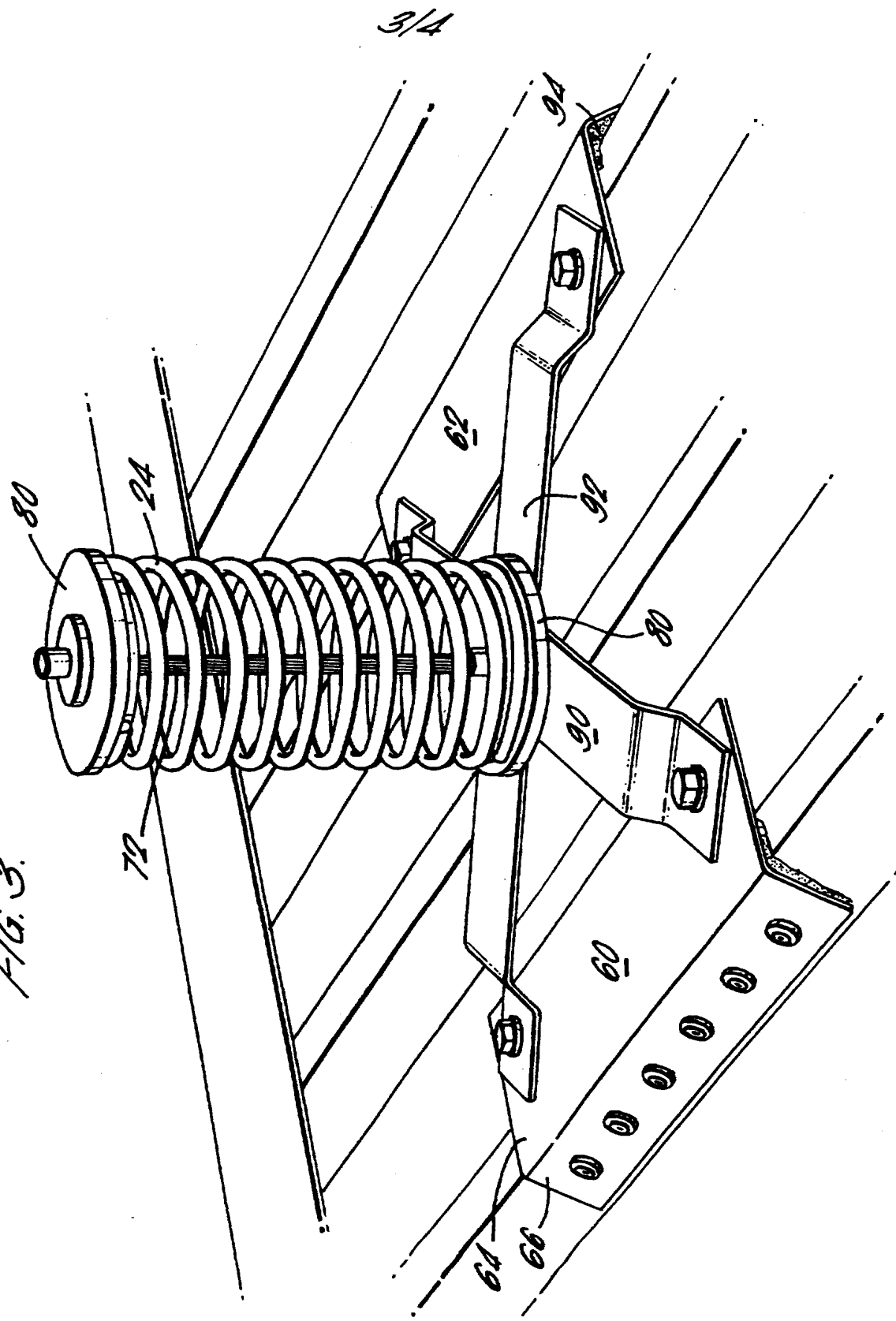
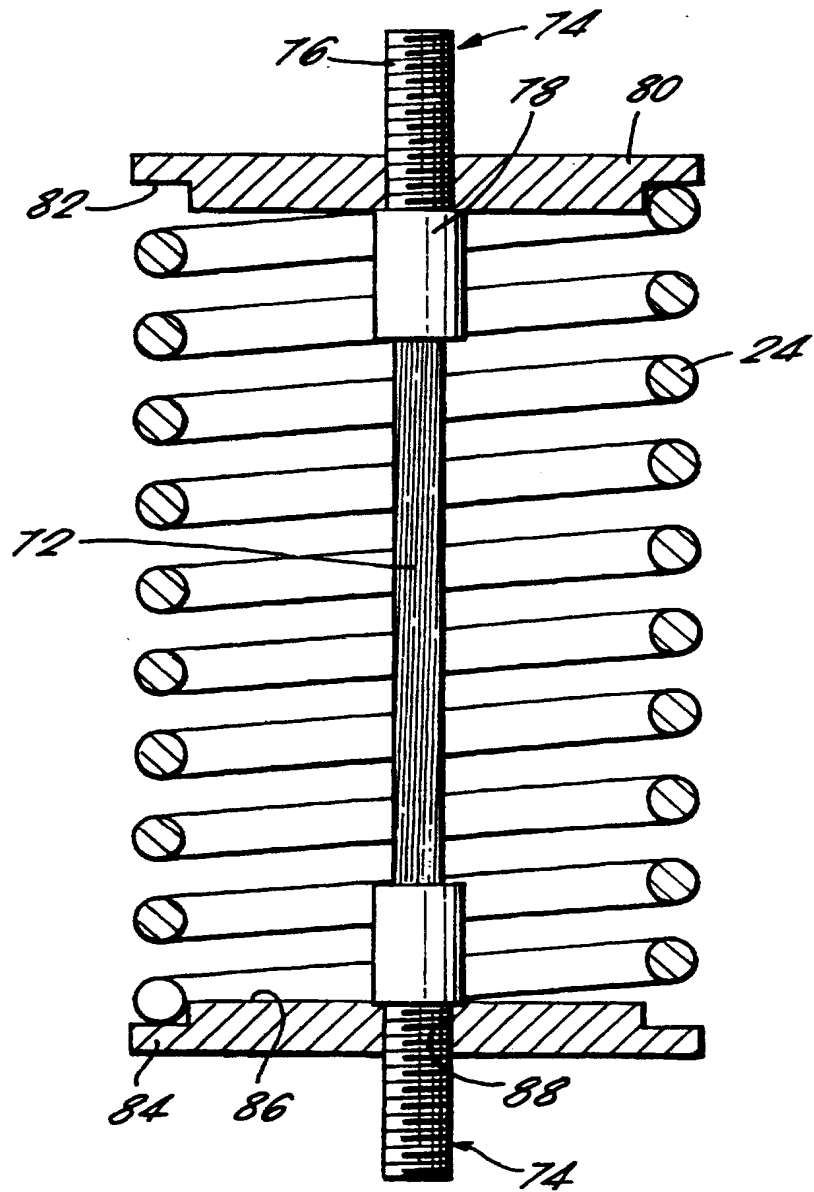


FIG. 4.



SHOCK ABSORBING SUPPORT AND FALL-ARREST SYSTEM

5       The present invention relates to a shock  
absorbing support for use in a personnel fall-arrest  
or fall-restraint system and to a fall-arrest or fall-  
restraint system comprising a shock absorbing support.

10       Personnel fall-arrest systems generally comprise  
a flexible cable or cable network which is anchored in  
spaced relation to a rigid structure, such as a  
building, by supports located at intervals along the  
cable or cable network. A coupling component is  
typically provided for connecting a worker's safety  
15       line or lanyard, the coupling component being coupled  
to the cable or cable network but being freely  
displaceable therealong. Systems of this type serve  
to protect workers in situations where they would  
otherwise be exposed to a risk of serious injury or  
20       death by falling. For example, they can be used for  
protecting workers on the exteriors of structures such  
as roofs, high above the ground, or on walkways above  
open vats or other containers holding harmful liquids.

25       If a fall occurs, it is desirable to reduce the  
shock loading produced when the fall is arrested in  
order to reduce the chance of injury to the falling  
person and to minimise the forces applied to the  
components of the fall-arrest system and to the rigid  
structure to which the system is anchored. To this  
30       end it is usual for shock absorbing means to be  
incorporated within the system such as, for example,  
in association with the worker's safety harness or the  
safety line or lanyard by which the safety harness is  
connected to the cable or cable network.

35       In addition it is known from EP-B-0,484,494 to

provide supports which, although capable of preventing release of the cable or cable network under the greatest load liable to be imposed on them in the event of a fall of a person using the system, nevertheless are adapted to undergo obvious permanent deformation under a load substantially smaller than that maximum. This not only provides the advantage of making it obvious that the system has been subjected to a heavy load and that repair work must be carried out before the system can be certified for re-use but also means that the supports themselves provide a certain degree of shock absorbing capability.

A similar shock absorbing support forms the subject of GB-B-2,325,719 which is described as intended to provide an omnidirectional shock absorbing support which again provides a clear visual indication when it has been subject to a high load. However, since the support comprises at least three deformable arms arranged symmetrically about a raised cable receiving anchor element in a pyramidal formation, it is clear that the shock absorbing characteristics of the support are not independent of the angle at which the fall occurs with respect to the support. Taking the four armed embodiment of the specific description, for example, one could expect the shock absorbing properties of the support to be different if a person using the system fell at an angle to the support which coincided with one of the deformable arms compared to a fall at an angle lying between two of the arms. At best with such a design the shock absorbing characteristics will be symmetrical about an angle of 90°. Accordingly there still remains a need for a truly omnidirectional shock absorbing support for use in a personnel fall-arrest system.

Furthermore, although there are numerous systems

in existence for providing an indication that a fall-arrest system has been subject to a high load, it would nevertheless be advantageous if the omnidirectional shock absorbing support could provide  
5 a clear visual indication that it has been subjected to a load commensurate with a fall having taken place. In this way a supervisor of the system is readily prompted to carry out a thorough check on the system and replace any damaged components before the system  
10 is again put to use.

According to a first aspect of the present invention there is provided a shock absorbing support for use in a personnel fall-arrest system, the support comprising a base and an anchor element joined to the  
15 base by helical spring means.

According to a second aspect of the present invention there is provided a personnel fall-arrest or fall-restraint system comprising: a cable; shock absorbing supports for holding the cable in spaced  
20 relation to a structure and which are located at intervals along the cable; a safety line connectable to a worker's safety harness; and a coupling component for connecting said safety line to said cable, the coupling component being coupled to the cable and  
25 being freely displaceable therealong, the shock absorbing supports comprising a base for attachment to the structure and an anchor element for receipt of the cable, the anchor element being joined to the base by helical spring means.

30 A number of embodiments of the present invention will now be described by way of example with reference to the accompany drawings in which:

Figure 1 is a schematic view of part of a personnel fall-arrest system shown mounted in relation  
35 to a profiled roof structure;



Figure 2 is a cross-sectional view of part of a shock absorbing support but with the anchor element omitted;

5 Figure 3 is a perspective view of a shock absorbing support in accordance with a preferred embodiment of the present invention; and

Figure 4 is a cross-sectional view of part of the shock absorbing support of Figure 3.

10 Referring to Figure 1 there is shown a schematic view of part of a fall-arrest system comprising a cable 10 anchored to a structure 12 by means of a plurality of shock absorbing supports 14. The cable 10 can follow an endless course around the structure or else it may simply extend between two spaced  
15 locations at which the ends of the cable are secured to the structure via suitable end anchors. A coupling component 16 is threaded onto the cable 10 and is freely slidable therealong. In particular, the movement of the coupling component 16 is not impeded  
20 by the supports 14 located at intervals along the length of the cable 10. A worker's safety harness is connected to the coupling component 16 via a lanyard 18. The lanyard 18 may typically incorporate an additional shock absorbing device so that, in the  
25 event of a fall, the worker is not subjected to so abrupt an arrest of the fall as could itself cause serious injury.

A shock absorbing support 14 is shown in more detail in Figure 2 to comprise a base 20 and an anchor  
30 element 22 through which the cable 10 is threaded and which is joined to the base 20 by a helical spring 24. The helical spring 24 comprises a plurality of circular coils 26 and defines first and second ends 28 and 30, the first end being secured to the base 20 and  
35 the second end being secured to the anchor element 22.

In the example shown, the first end 28 is secured to the base 20 via a projecting boss 32 which is itself secured to the base by means of one or more threaded bolts 34 which pass through respective apertures provided in the base and are received within respective complimentary threaded recesses 36 provided on an underside of the boss. The first end 28 of the helical spring 24 is also threaded and is received within in a complimentary threaded blind bore 38 provided centrally of an upper surface 40 of the boss 32.

Similarly, the second end 30 is secured to the anchor element 22 by means of a top plate 42. Like the first end 28, the second end 30 of the helical spring 24 may be threaded so as to threadingly engage a blind bore 44 located on an undersurface 46 of the top plate 42 while an upper surface 48 of the top plate may be provided with a tapped hole 50 with which to receive a projecting portion of the anchor element 22.

In use the base 20 is secured by any suitable means, such as by bolts or rivets, to the structure 12 to which the fall-arrest system is to be mounted. The cable 10 is strung between the shock absorbing supports 14, threaded through the anchor elements 22 and suitably tensioned. When a worker wishes to make use of the system, a coupling component 16 attached to the worker's safety harness via a lanyard 18 is coupled onto the cable 10. This enables the worker to move in safety around the structure 12 without fear of falling. If a fall should occur, the load generated by the fall is transferred via the worker's safety harness and lanyard 18 to the fall-arrest system where it is resisted and the fall-arrested. In so doing part of that load will be borne by one or more of the

shock absorbing supports 14 which will typically bend and flex depending on the spring constant of the helical spring 24. Because of the ability of the helical spring 24 to deform, whether elastically or plastically, the support 14 is able to absorb at least some of the shock which in a more rigid system would otherwise be transferred either to the structure 12, with the risk of consequent damage, or to the safety harness, with the risk of consequent injury to the worker. Furthermore, because the helical spring 24 is symmetrical about a central, generally vertical axis, the shock absorbing properties of the support 14 are truly omnidirectional and so can be optimised in terms of the length and spring constant of the helical spring 24 and yieldability of the connections between the anchor element 22 and the helical spring 24, the helical spring 24 and the base 20 and between the base 20 and the structure 12 irrespective of the direction in which the fall occurs.

Although the base 20 may be of any suitable shape, the base is preferably shaped so as to conform to the profile of the surface to which it is to be mounted. The surface may be planar but typically fall-arrest systems are mounted on profiled roof structures defined by a plurality of trapezoidal crowns 54 which extend generally parallel to each other at spaced intervals separated by a valleys 56. Although the base 20 may be adapted so as to be attached to any particular one of the crowns 54 nevertheless, as shown in Figure 1, the base preferably spans two adjacent crowns and is secured to each of them. This serves to provide the base 20 with greater stability. However, because profiled roofing sheets are manufactured with crowns 54 spaced at different pitches and with crowns and valleys 56 of

different dimensions, the base 20 is preferably adapted so as to be able to conform to a number of different profile shapes.

To this end, as shown in Figure 2, the base 20 preferably comprises a central, substantially planar portion 58 and two separate angled portions or feet 60 and 62 for attachment to the central portion along respective opposing side edges. The angled portions 60 and 62 each comprise a first surface 64 occupying a plane substantially parallel to the central portion 58 and a second surface 66 occupying a plane substantially parallel to a web 68 of the profiled roof structure and which intersects the first surface 64 in such a way as to subtend an obtuse included angle.

In use the respective second surfaces 66 of the two angled portions 60 and 62 are secured to the outer webs 68 of two adjacent crowns 54 by means of suitable fasteners, such as by bolts or rivets, while the respective first surfaces 64 are secured to the central, planar portion 58, again by any suitable fastening means, in such a way as to accommodate one of a range of pitches between the crowns 54. For example, the first surfaces 64 may be secured to the central portion 58 by one or more bolts 70 passing through elongate slots rather than circular apertures in one or both of the central and angled portions, the slots being elongated in a direction orthogonal to the direction of elongation of the crowns 54 so as to enable the base 20 to present a footprint of variable width. Alternatively, rather than an elongated slot, one or both of the central and angled portions 58 and 60, 62 may be provided with a series of apertures which are again spaced in a direction orthogonal to the direction of elongation of the crowns 54. In this

way, although no longer infinitely variable within a predetermined range, the two angled portions 60 and 62 may nevertheless be spaced apart to one of a plurality of predetermined distances while still being joined to the central planar portion 58.

5 It will be apparent to those skilled in the art that by securing the base 20 to the roof structure in the manner described, the shock absorbing support 14 is not constrained, like so much of the prior art, to  
10 be positioned in relation to a purlin, rafter or zed spacer support.

Although the central planar portion 58 is shown as formed of a solid plate, the base 20 may nevertheless be pierced so as to define a lattice work  
15 of bars that is nonetheless capable of withstanding the loads that it is likely to be subjected to. The advantage of such a lattice work structure can be seen in terms of its reduced weight and raw material cost. Alternatively, the base 20 may be made up of a  
20 plurality of bars joined together to form a lattice. In particular the base may comprise two diagonal bars each extending from one end of one of the two angled portions to the opposite end of the other of the two angled portions. The two diagonal bars may be joined  
25 together at their centres where they cross.

Although the helical spring 24 has been described as secured to the base 20 by means of boss 32, it will be appreciated that the spring may be secured to the base by any suitable means and, in particular, may be  
30 secured directly to the base without requiring the use of an intervening element such as boss 32. For example, the helical spring 24 may be secured directly to the base 20 by one or more inverted U-shaped bolts whose ends protrude through apertures provided in the  
35 base to be engaged by correspondingly threaded nuts

and whose mid-portion loops over an end coil 26 of the spring to hold the spring in abutting relationship with the base 20. A similar arrangement may be used at the opposite end of the spring to secure the second  
5 end 30 to the anchor element 22.

Although the spring has been described as formed of coils 26 which in plan view are substantially circular, the coils of the helical spring 24 may in  
10 general be of any convenient shape and may, for example, be oval or elliptical. Alternatively, the coils may, in plan view, have a shape which is triangular, square, rectangular, pentagonal, hexagonal, heptagonal or octagonal. The spring 24 can be formed of any suitable material and may, for  
15 example, be formed of stainless steel in order to be suitably weather resistant. Alternatively, the spring may be formed of a different material such as mild steel and then coated with a plastics or other suitable protective material. In addition, or as a  
20 further alternative, the helical spring 24 may be provided with a protective sheath.

Although the anchor element 22 has been described as joined to the base 20 by means of a single helical spring 24, it will be apparent that the two may be  
25 joined by additional means beside the spring. For example, the two may be joined by one or more additional springs in parallel or in series with the helical spring 24. In this way the shock absorbing support 14 may exhibit a more complex response to an  
30 applied load. For example, if an additional spring having a different spring constant was placed in series with the helical spring 24, the shock absorbing support 14 may respond with a first characteristic over one range of applied loads (until such time as  
35 one of the springs reached its elastic limit) and with

a second characteristic for loads in excess of that range.

5 As well as additional springs, the additional means joining the anchor element 22 to the base 20 may include means for limiting the extension or deformation of the helical spring 24 when the fall-arrest system is under load. For example, the helical spring 24 may be positioned in parallel with a link which joins the anchor element 22 to the base 20 and which allows the spring to extend or otherwise deform  
10 but only up to a predetermined limit. Advantageously the link, which may take the form of an inelastic cable, may be adapted so as to enable the predetermined limit to be adjustable.

15 Thus, in the preferred embodiment shown in Figure 3 the shock absorbing support 14 comprises an anchor element 22 which is joined to the base 20 by a helical spring 24 and by a coaxial inelastic cable 72. As can be seen more clearly in Figure 4, in this embodiment the inelastic cable 72 preferably comprises  
20 an 8mm stainless steel cable, 110mm in length, swaged at opposite ends to two oppositely directed, but otherwise identical, end pieces 74. Each of the end pieces 74 is preferably 60mm in length and comprises a threaded portion 76, 35mm in length, and a non-  
25 threaded stub 78, 25mm in length, which is of greater diameter than the threaded portion 76 and which is joined to the inelastic cable 72.

30 In this embodiment the boss 32 and top plate 42 of the previous embodiments are replaced by two oppositely directed, but otherwise identical, collars 80 which are preferably substantially circular in plan view but which, in cross-section, define a step 82 between a first portion 84, 100mm in diameter, and a  
35 second coaxial portion 86, formed integrally with and

projecting from the first, which is 76mm in diameter. Both portions 84 and 86 are preferably 5mm in thickness and have a central threaded throughbore 88 for the receipt of the threaded portion 76 of one of the end pieces 74. Preferably the two collars 80 may  
5 be injection moulded and formed of glass re-enforced nylon. Alternatively, the collars 80 may be formed of polycarbonate.

The helical spring 24 is preferably formed of 8mm  
10 stainless steel conforming to BS2056 302 S26. The helical spring 24 is retained by the two collars 80 which are arranged so that their respective second portions 86 project into the volume enclosed by the coils from opposite ends and so that the first and  
15 second ends of the spring 28 and 30 are engaged by the steps 82. The collars 80 are held in spaced relationship with respect to each other against the action of the helical spring 24 (which would otherwise tend to move the collars apart) by the threaded  
20 receipt of the end pieces 74 in the respective throughbores 88. As can be seen from Figure 4, the length of the threaded portions 76 and the thickness of the collars 80 are such that approximately 25mm of the threaded portion 76 projects beyond the collar and  
25 can be used to secure the collar and cable to either the base 20 or anchor element 22 as appropriate.

As previously discussed, the base 20 may comprise two diagonal bars or cross-braces 90 and 92, each extending from one end of one of the two angled  
30 portions 60 and 62 to the opposite end of the other of the two angled portions. In this embodiment the two cross-braces are joined together at their centres where they cross and to one of the collars 80 by the receipt of that part of the threaded portion 76 which  
35 projects beyond the collar 80 within two mutually



aligned apertures provided in each of the cross-braces and which is then secured by a correspondingly threaded nut (not shown). The cross-braces are preferably formed of grade 304 stainless steel and are 5 410mm in length, 50mm wide and 2mm thick. Likewise, the two angled portions 60 and 62 are preferably also formed of grade 304 stainless steel, are 320mm x 115mm and 2mm thick with the second surfaces 66 angled with respect to the first surfaces 64 so as to suit 10 different roof profiles. A malleable filler medium 94 may be provided at the intersection of the first and second surfaces 64 and 66 so as to ensure that the angled portion 60 and 62 conform to the profile of the roof to which the system is to be applied. If desired 15 this filler medium 94 may also comprise an adhesive.

In order to provide evidence that a fall has taken place, frangible means, perhaps in the form of a breakable wire or tape, may be provided in conjunction with the helical spring 24 such that when the spring 20 extends or is otherwise deformed under a load the wire or tape breaks to provide evidence of the load having been applied to the system. To this end the frangible means is attached to the spring at locations whose spacing will increase upon the application of such a 25 load. Preferably the frangible means is adapted so as to only break when the helical spring 24 is subjected to a load commensurate with a fall having taken place and not to break at lesser loads.

In one embodiment the helical spring 24 may take 30 the form of a closed coil spring and the frangible means take the form of a wire or tape extending up an exterior of the spring in a direction generally parallel to the spring axis, the frangible wire or tape being joined to individual coils of the spring so 35 that when a load is applied to the system and the

coils open, the frangible wire or tape breaks as evidence of a fall having taken place. Having said that, it will be apparent that the frangible means need not be joined directly to the spring 24 in order to have this effect and may instead, be joined to, for example, the base 20 and the anchor element 22 or between the boss 32 and the top plate 42.

Although the illustrated shock absorbing supports 14 have been described as one of plurality of such supports disposed at intervals along a cable 10 as part of a fall-arrest system, it will be apparent that they may equally serve as end anchors or as an isolated anchor to which a worker may directly attach his safety harness via lanyard 18. The shock absorbing supports may also find use as part of a fall-restraint system in which the components of the system are positioned so as to make an actual fall impossible, for example, by constraining a worker to keep away from an edge of a roof.

CLAIMS:

- 5 1. A shock absorbing support for use in a personnel fall-arrest system, the support comprising a base and an anchor element joined to the base by helical spring means.
- 10 2. A shock absorbing support in accordance with claim 1 wherein said helical spring means has first and second ends, said first end being secured to the base and said second end being secured to said anchor element.
- 15 3. A shock absorbing support in accordance with claim 1 or claim 2 wherein said base is shaped so as to conform to the profile of a surface to which the support is to be mounted.
- 20 4. A shock absorbing support in accordance with any preceding claim, wherein said base comprises a first portion to which said helical spring means is attached and one or more second portions which are adapted to be secured to the surface to which the support is to  
25 be mounted.
- 30 5. A shock absorbing support in accordance with claim 4, wherein said first and second portions are adapted to be fastened together in any one of a plurality of relative positions.
- 35 6. A shock absorbing support in accordance with claim 4 or claim 5 wherein said first portion is substantially planar.

7. A shock absorbing support in accordance with claim 6 wherein the or each second portion comprises a first surface occupying a plane substantially parallel to said first portion and a second surface which  
5 intersects said first surface and which is adapted to be secured to the surface to which the support is to be mounted.

8. A shock absorbing support in accordance with any  
10 of claims 4 to 7 wherein said second portions extend in generally parallel relationship and said first portion comprises two or more cross-braces interconnecting said second portions.

9. A shock absorbing support in accordance with claim 8 wherein some or all of said cross-braces are joined together in regions where they overlap.

10. A shock absorbing support in accordance with any  
20 preceding claim wherein the base is pierced to form a lattice.

11. A shock absorbing support in accordance with any preceding claim wherein the base is formed of a  
25 lattice of interconnecting bars.

12. A shock absorbing support in accordance with any preceding claim wherein the coils of the helical spring means are closed when the shock absorbing  
30 support is not under load.

13. A shock absorbing support in accordance with any preceding claim wherein the helical spring means is provided with a protective sheath.

14. A shock absorbing support in accordance with any preceding claim wherein the anchor element is additionally joined to the base by means of a member which serves to limit the deformation of the spring means when the shock absorbing support is under a load in excess of a predetermined value.

15. A shock absorbing support in accordance with claim 14 wherein said member is adjustable so as to vary said predetermined value.

16. A shock absorbing support in accordance with claim 14 or claim 15 wherein said member is positioned in parallel with said spring means.

17. A shock absorbing support in accordance with any of claims 14 to 16 wherein said member comprises a cable extending coaxially with said spring means.

18. A shock absorbing support in accordance with any preceding claim wherein said helical spring means comprises coils having a shape selected from the list comprising circular, oval, elliptical, triangular, square, rectangular, pentagonal, hexagonal, heptagonal and octagonal.

19. A shock absorbing support in accordance with claim 18 wherein said spring means is attached to either said base or said anchor element by means of a stepped collar, at least a part of said collar extending into the volume defined by the coils of said spring means.

20. A shock absorbing support in accordance with any preceding claim wherein said spring means is attached

to the base by one or more substantially U-shaped bolts.

5 21. A shock absorbing support in accordance with any preceding claim wherein frangible means is joined to the spring means at spaced locations such that, when the spring means is deformed under a load in excess of a predetermined value, the frangible means breaks to provide evidence of said load having been applied.

10 22. A shock absorbing support in accordance with claim 21 wherein said frangible means comprises an elongate member which extends along an exterior of said spring means generally parallel to a longitudinal axis of said spring means and which is joined to the spring means directly or indirectly at opposite ends.

20 23. A shock absorbing support for use in a personnel fall-arrest system, the support being substantially as herein described with reference to the accompanying drawings.

24. A personnel fall-arrest or fall-restraint system comprising:  
25 a cable;  
shock absorbing supports for holding the cable in spaced relation to a structure and which are located at intervals along the cable;  
a safety line connectable to a worker's safety  
30 harness; and  
a coupling component for connecting said safety line to said cable, the coupling component being coupled to the cable and being freely displaceable therealong, the shock absorbing supports comprising a  
35 base for attachment to the structure and an anchor

element for receipt of the cable, the anchor element being joined to the base by helical spring means.

5 25. A personnel fall-arrest or fall-restraint system in accordance with claim 24 wherein said shock absorbing support is in accordance with any of claims 2-23.

10 26. A personnel fall-arrest or fall-restraint system in accordance with claim 24 or claim 25 and comprising additional shock absorbing means for avoiding such abrupt an arrest of a worker's fall as could cause personnel injury.

15 27. A personnel fall-arrest or fall-restraint system substantially as herein described with reference to the accompanying drawings.



INVESTOR IN PEOPLE

Application No: GB 0006412.1  
Claims searched: 1 to 27

Examiner: Colin Thompson  
Date of search: 26 June 2000

## Patents Act 1977 Search Report under Section 17

### Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:  
UK CI (Ed.R): F2S (SCB); E1S (SL); B8B (BDD); F2X  
Int CI (Ed.7): A62B 1/16,35/04; E04G 21/32; E06C 7/18  
Other: Online: WPI, EPODOC, JAPIO

### Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
X	GB 2226071 A (Queen) See spring 16	1,2,4,14,18
X	GB 1131310 A (Barrow Hepburn & Gale Ltd) See Figs 2 & 3	1,2,14,18
X	GB 597563 A (Clerk) See Fig 1	1,2,14,18
X	EP 0075055 A1 (Perez) See whole document	1,2,4,6,14,18,24,25
X	WO 94/08658 A1 (Rose Systems Inc) See Fig 1	1,2,14,21,22
X	US 4702507 A (Medendorp) See especially Figs 2 & 3	1,2,14,17,18

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.